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A note on equilibrium leadership  
in tax competition models

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**A note on equilibrium leadership in tax competition models**

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**Abstract**

This paper reexamines the work of Kempf and Rota-Graziosi (J. Pub. Econ. 94: 768-776, 2010), which shows that leadership by the small region is the risk dominant equilibrium under the endogenous timing game. They obtain this result in a model where the asymmetry among countries translates into different gradients of the demand for capital but identical vertical intercept. In this note, we simply reverse the form of asymmetry by considering different vertical intercepts but identical gradient. The reason is that market power is typically related to the intercept and not to the slope of the demand function. We then show that the large region tax leadership becomes the risk dominant equilibrium and can even become Pareto superior.

**Keywords:** endogenous timing, tax competition, reaction function.

**JEL classification:** H30, H87, C72.

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# 1 Introduction

In most tax competition models, it was assumed that countries set taxes simultaneously. But some authors have recently shown that tax leadership is not only natural but could even be beneficial. Wang (1999) asserts that “*it is natural and conceivable that, in a real-world situation of tax setting, the large region moves first*” (p. 974). However, tax leadership by the large countries is assumed<sup>1</sup> but not demonstrated, and this assumption was recently challenged by Kempf and Rota Graziosi (2010). Using the pre-play stage as in Hamilton and Slutsky (1990) to determine the equilibrium timing, they find that leadership by the small region is the risk dominant outcome.<sup>2</sup> To obtain this result, they use a linear demand for capital in which the regional asymmetry translates into different gradients but identical vertical intercept. The large region has the smaller gradient for the demand function so that the productivity of capital declines less rapidly with the amount of capital. We find this definition of the large region somewhat at odds with the general perception in the asymmetric tax competition models. Indeed the intuitive leadership by the large region is based its ability to exploit market power. The large region has greater market power that permits to benefit from higher tax rates. In that perspective, small region is generally thought to face more elastic demand for capital, and therefore to have stronger incentives to offer lower tax rates. Under linear demand for capital, the markup, which measures market power, is independent of the gradient, but is related to the vertical intercept of the demand function. In that sense, different market power should translate into different vertical intercept but identical gradients. That is just the opposite of what Kempf and Rota-Graziosi (2010) assumed.

Adopting this alternative approach, we can reconcile the equilibrium outcome with the conventional wisdom: tax leadership by the large region risk dominates and can possibly Pareto dominates the tax leadership by the small region. We can also relate our result to the literature on cross border shopping and on profit shifting.

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<sup>1</sup>Baldwin and Krugman (2004) also make the same assumption of the large (core) region’s leadership to show that equilibrium tax rates remain higher in the core region than in the small (periphery).

<sup>2</sup>Ogawa (2013) showed that the simultaneous-move outcome may prevail as The Subgame Perfect Equilibrium if the capital is owned by residents in the countries. In this paper we assume that the capital is owned by nonresidents as in Kempf and Rota-Graziosi (2010), so that The Subgame Perfect Equilibria of the timing game are the two Stackelberg equilibria.

## 2 The model and the result

The model used follows closely Kempf and Rota-Graziosi (2010). There are two regions, denoted by  $A$  and  $B$ , where capital is mobile and the two fiscal authorities set capital taxes. The production in region  $i$  is represented by the function  $F_i(K_i) = (a_i - bK_i)K_i$  where  $K_i$  is the amount of capital in region  $i$ . The  $a_i$  represents the vertical intercept of the demand for capital. We assume that  $a_A > a_B$ , with identical gradient  $b > 0$  in both regions. The large region is region  $A$  with the higher vertical intercept. Kempf and Rota-Graziosi (2010) considered the case of identical  $a$  but different  $b_i$ . We will come back to this point later.

The welfare function of region  $i$  is the same as Eq. (2) of Kempf and Rota-Graziosi (2010):

$$W_i = F_i(K_i) - K_i F'_i(K_i) + t_i K_i. \quad (1)$$

Namely, it is the sum of labor income ( $F_i(K_i) - K_i F'_i(K_i)$ ) and the capital tax income ( $t_i K_i$ ). The total supply of capital is fixed  $\bar{K}$ , and the capital is perfectly mobile between regions. The arbitrage and the market clearing conditions involve:

$$F'_A(K_A) - t_A = F'_B(K_B) - t_B, \quad K_A + K_B = \bar{K},$$

which yield:

$$K_i(t_i, t_j) = \frac{1}{4} \frac{a_i - a_j + t_j - t_i + 2b\bar{K}}{b} \quad (i, j = A, B, \quad j \neq i). \quad (2)$$

To insure interior solution, we assume:

**Assumption 1**  $a_A - a_B < 4b\bar{K}$ .

To derive the equilibrium of the Hamilton-Slutsky's (1990) timing game, we first derive the equilibrium of three tax games: (i) Simultaneous game  $G^N$  where each region chooses  $t_i$  simultaneously and non-cooperatively, (ii) Stackelberg Game  $G^A$  where region  $A$  leads in the choice of the tax rates, and (iii) Stackelberg Game  $G^B$  where region  $B$  leads. For a given pair of  $(a_A, a_B)$ , Table 1 lists the tax rates and the welfare levels at the equilibria of the three tax games.

The timing game has the pre-play stage where the regions decide whether to move *Early* or *Late*. If both regions choose to move *Early* or *Late*, the

	$G^N$	$G^A$	$G^B$
Region $A$			
$t_A$	$\frac{1}{4}(a_A - a_B) + b\bar{K}$	$\frac{2}{5}(a_A - a_B) + \frac{8}{5}b\bar{K}$	$\frac{1}{5}(a_A - a_B) + \frac{6}{5}b\bar{K}$
$W_A$	$\frac{3}{64} \frac{(a_A - a_B + 4b\bar{K})^2}{b}$	$\frac{1}{20} \frac{(a_A - a_B + 4b\bar{K})^2}{b}$	$\frac{3}{100} \frac{(a_A - a_B + 6b\bar{K})^2}{b}$
Region $B$			
$t_B$	$-\frac{1}{4}(a_A - a_B) + b\bar{K}$	$-\frac{1}{5}(a_A - a_B) + \frac{6}{5}b\bar{K}$	$-\frac{2}{5}(a_A - a_B) + \frac{8}{5}b\bar{K}$
$W_B$	$\frac{3}{64} \frac{(a_A - a_B - 4b\bar{K})^2}{b}$	$\frac{3}{100} \frac{(a_A - a_B - 6b\bar{K})^2}{b}$	$\frac{1}{20} \frac{(a_A - a_B - 4b\bar{K})^2}{b}$

Table 1: Tax rates and welfare levels in  $G^N$ ,  $G^A$  and  $G^B$

induced tax competition is  $G^N$ . If one region  $i$  chooses *Early* and the other region  $j$  chooses *Late*, the tax competition is a sequential game  $G^i$  ( $i = A$  or  $B$ ), and ends up with the Stackelberg-equilibrium welfare levels  $(W_i^L, W_j^F)$ . Table 1 is consistent with Proposition 2 of Kempf and Rota-Graziosi (2010), so that The Subgame Perfect Equilibria (SPEs) of the timing game (Kempf and Rota-Graziosi (2010, p. 772)) are the two Stackelberg equilibria of the tax game. Next, in order to deal with the coordination issue due to the multiplicity of the equilibria of the timing game, we use Harsanyi and Selten's (1988) risk-dominance criterion. Following Eq. (11) of Kempf and Rota-Graziosi (2010), the equilibrium  $(Early, Late)$  risk-dominates  $(Late, Early)$  if and only if:

$$\Pi \equiv (W_A^L - W_A^N)(W_B^F - W_B^N) - (W_A^F - W_A^N)(W_B^L - W_B^N) > 0 \quad (3)$$

In the Appendix we show that, opposite to Kempf and Rota-Graziosi (2010, Proposition 3. (i)), the leadership of the large region is the risk-dominant equilibrium of the timing game. Moreover, as in Kempf and Rota-Graziosi (2010, Proposition 3. (ii)) and Amir and Stepanova (2006, Proposition 6), our risk-dominating equilibrium  $(Early, Late)$  Pareto dominates  $(Late, Early)$  when regional asymmetry is sufficiently high.<sup>3</sup> Namely, Pareto-dominance reinforces the risk-dominance.

**Proposition 1** *Under asymmetry in market power as represented by different vertical intercepts of the capital demand ( $a_i$ ):*

*(i) The large region leadership risk-dominates. (ii) If the asymmetry is sufficient ( $a_A - a_B > rb\bar{K}$  with  $r \approx 2.872983$ ), the large region leadership is Pareto-dominant.*

<sup>3</sup>That is, the small region  $B$  has a second-mover advantage for all  $(a_A, a_B)$ , but the large region  $A$  has a first-mover advantage with sufficient asymmetry.

### 3 Discussion

In this section we give interpretations of the difference between our result and Kempf and Rota-Graziosi (2010). We attribute the difference to their implicit assumption on the asymmetry in the tax reaction function.

In our model, the tax reaction functions  $\hat{t}_i(t_j) \equiv \arg \max_{t_i} W_i(t_i, t_j)$  are

$$\hat{t}_A(t_B) = \frac{1}{3}t_B + \frac{1}{3}(a_A - a_B) + \frac{2}{3}b\bar{K}, \quad \hat{t}_B(t_A) = \frac{1}{3}t_A - \frac{1}{3}(a_A - a_B) + \frac{2}{3}b\bar{K}. \quad (4)$$

Here, the reaction functions differ only by the vertical intercepts, with higher intercept for the large region  $A$ . This implies that the large region  $A$  benefits from higher taxes.

On the other hand, in Kempf and Rota-Graziosi (2010), production is given by  $F_i(K_i) = (a - b_i K_i)K_i$ . Large region  $A$  implies  $b_A < b_B$  (i.e. region  $A$  is more productive (large in their sense)). The induced tax reaction function of region  $i$  is:

$$\hat{t}_A(t_B) = \frac{b_B}{b_A + 2b_B}t_B + \frac{2\bar{K}b_B^2}{b_A + 2b_B}, \quad \hat{t}_B(t_A) = \frac{b_A}{b_B + 2b_A}t_A + \frac{2\bar{K}b_A^2}{b_B + 2b_A}. \quad (5)$$

Here, the regional asymmetry translates into difference in the gradients of the reaction functions. Namely, the large region is more responsive to the tax choice of the small region ( $\partial \hat{t}_A / \partial t_B > \partial \hat{t}_B / \partial t_A$  in (5)). Therefore, tax leadership by the small region is preferable to induce a greater positive reaction in the tax rate of the large region, than the other way round. In our model, marginal tax responses are identical ( $\partial \hat{t}_A / \partial t_B = \partial \hat{t}_B / \partial t_A = 1/3$  in (4)), and the leadership from the large region emerges. Amir and Stepanova (2006, Proposition 6) is closely related to the points we made here. They showed that in a Bertrand duopoly game the low-cost (large) firm is the leader. The structure of risk-dominance and Pareto-dominance is identical to our Proposition 1 (i) and 1 (ii) whereby their cost asymmetry implies different markups. Our points here can also clarify why Kempf and Rota-Graziosi's (2011) cross-border shopping model obtains a risk-dominance of the small region's leadership. It is partly driven by the fact that the large region is more responsive to the other region's tax increase when their heterogeneity parameter  $\theta$  is sufficiently small. Another factor is the shifts in the intercepts of the reaction functions, depending on the location of the cross-shoppers (Figure 2 of Kanbur and Keen, 1993). They favor the welfare level of the small leadership equilibrium compared with that of the large leadership equilibrium.<sup>4</sup>

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<sup>4</sup>Once these effects are removed so that there is only different vertical intercept in the

We do not claim our modeling is better, but we believe that it is a more natural modelling of asymmetry if we want to capture difference in market power.

## Appendix: proof of Proposition 1

For part (i), from the values in Table 1, the derivation of product is:

$$\Pi = \frac{3}{4000} \frac{\bar{K}(a_A - a_B)(24b^2\bar{K}^2 - (a_A - a_B)^2)}{b} \quad (6)$$

Under Assumption 1,  $(a_A - a_B)^2 < 16b^2\bar{K}^2$ , so that  $\Pi > 0$ .

For part (ii), we can derive  $W_B^F - W_B^L = \frac{b\bar{K}^2}{50} \left( -\frac{(a_A - a_B)^2}{b^2\bar{K}^2} + 2\frac{a_A - a_B}{b\bar{K}} + 14 \right) > 0$  under Assumption 1, and  $W_A^F - W_A^L = \frac{b\bar{K}^2}{50} \left( -\frac{(a_A - a_B)^2}{b^2\bar{K}^2} - 2\frac{a_A - a_B}{b\bar{K}} + 14 \right) \geq 0 \iff a_A - a_B \leq rb\bar{K} \approx 2.872983b\bar{K}$ . When  $a_A - a_B > rb\bar{K}$ , the outcome of *(Early, Late)* Pareto-dominates that of *(Late, Early)*. *Q.E.D.*

## References

- [1] Amir, R. and A. Stepanova, 2006. Second-mover advantage and price leadership in Bertrand duopoly, *Games and Economic Behavior*, 55(1), pages 1-20.
- [2] Baldwin, R.E., Krugman, P., 2004. Agglomeration, integration and tax harmonisation, *European Economic Review*, 48(1), pages 1-23.
- [3] Harsanyi, J.C., and Selten, R. 1988. *A general theory of equilibrium selection in games*. MIT Press, Cambridge, MA
- [4] Hamilton, J.H., and Slutsky, S.M., 1990. Endogenous timing in duopoly games: Stackelberg or Cournot equilibria. *Games and Economic Behavior*, vol 2.1, pages 29-46.
- [5] Hvidt, M. and S.B. Nielsen, 2001. Non-cooperative vs. minimum-rate commodity taxation, *German Economic Review*, 2(4), pages 315-326.

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reaction functions as in Hvidt and Nielsen (2001), then the large leadership risk dominates and thus Kempf and Rota-Graziosi's (2011) results are reversed. This is shown by applying the results of Hindriks and Nishimura's (2014) profit shifting model to the cross-border shopping model.

- [6] Hindriks, J. and Y. Nishimura, 2014. International tax leadership among asymmetric countries, paper presented at CORE and University of Liège.
- [7] Kanbur, R., and M. Keen, 1993. Jeux sans frontieres: tax competition and tax coordination when countries differ in size, *American Economic Review*, 83(4), pages 877-892.
- [8] Kempf, H., and G. Rota-Graziosi, 2010. Endogenizing leadership in tax competition, *Journal of Public Economics*, vol 94, pages 768-776.
- [9] Kempf, H., and G. Rota-Graziosi, 2011 And the tax winner is ... Endogenous timing in the commodity taxation race, forthcoming in *Annals of Economics and Statistics*.
- [10] Ogawa, H., 2013. Further analysis on leadership in tax competition: the role of capital ownership, *International Tax and Public Finance*, 20, pages 474-484.
- [11] Wang, Y.-Q., 1999. Commodity taxes under fiscal competition: Stakelberg equilibrium and optimality, *American Economic Review*, vol 89, pages 974-981.



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